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ABSTRACT

Looking times of 36 children were recorded during subject-controlled presentation of slides in order to determine whether the existence of simple categories in 3-year-olds can be inferred from habituation data, and to determine any sex differences in conceptual generalization of habituation. Habituation was demonstrated over repeated presentation of 6 slides from a single conceptual category (e.g., animals). In an immediate generalization test the six habituated slides were intermixed with 6 unfamiliar, but similar, slides from the same category and 6 slides from a novel category (e.g., fruits). Mean looking times were shortest for familiar slides, longer for categorically similar slides, and longest for categorically novel slides. Females showed generalized habituation from the familiar slides to the categorically similar slides, but looked significantly longer at those from the novel category. Males looked significantly longer at new slides from either the similar or the novel category than at the familiar slides, but on unfamiliar slides did not significantly discriminate between the similar and novel categories. (Author/SB)

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GENERALIZED HABITUATION OF CONCEPT STIMULI IN TODDLERS

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Attention and Cognitive Styles

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Abstract

Looking times of 36 children were recorded during subject-controlled presentation of slides. Habituation was demonstrated over repeated presentation of 6 slides from a single conceptual category (e.g., animals). In an immediate generalization test the six habituated slides were intermixed with 6 unfamiliar, but similar slides from the same category and 6 slides from a novel category (e.g., fruits). Mean looking times were shortest for familiar slides, longer for categorically similar slides, and longest for categorically novel slides. Females showed generalized habituation from the familiar slides to the categorically similar slides, but looked significantly longer at those from the novel category. Males looked significantly longer at new slides from either the similar or the novel category than at the familiar slides, but on unfamiliar slides did not significantly discriminate between the similar and novel categories.

Generalized Habituation of Concept Stimuli in Toddlers

Patricia J. Faulkender, John C. Wright, & April Waldron

University of Kansas

The major purpose of this study is to determine whether the existence of simple categories in three-year-olds can reasonably be inferred from habituation data. It has been suggested by Kagan, Henker, Hen-Tov, Levine & Lewis (1966) and by Lewis (1967) that habituation is an indicator of the cognitive capacities of infants and young children. Jeffrey's (1968) serial habituation hypothesis makes use of successive habituation processes as the basis for formation of the earliest cognitive schemas. McCall & Kagan (1967) note that the subsequent development of meaning begins to compete with stimulus parameters for the control of attention, and in general it appears that recognition, meaning, and simple conceptual organization of experience may undergo considerable development in the first three years of life. This development, based on perceptual and attentional processes, may take place before the more potent verbal organizers become available.

Recovery of habituation and relatively greater dishabituation to novel than to habituated stimuli has been demonstrated by Pancratz & Cohen (1970) and by Friedman (1972) with infants. The same phenomena have been demonstrated in three-year-olds by Lewis & Goldberg (1967). Further evidence of a gradient of generalization for habituation in which the amount of recovery is proportional to the degree of structural novelty of test stimuli has been provided by Cohen, Gelber & Lazar (1971), Collard & Rydberg (1972) and McCall, Hogarty, Hamilton & Vincent (1973).

The present study is designed to evaluate selective generalization of habituation on the basis of meaningful categories of stimuli. If it can be shown that not only stimulus novelty, but also categorical novelty governs the recovery of visual attention, then it could be argued that such categorical equivalence indicates the presence of simple attentionally based concepts. Specifically, in the present study habituation of various members of a class of visual stimuli is followed by a test series containing the habituated stimuli, new stimuli which are members of the habituated category, and new stimuli which are members of a new category. If there is generalization of habituation to new instances of the habituated category, but recovery or dishabituation of attention to new instances of a novel category, then one would have evidence for attentionally mediated conceptual generalization. Moreover, if some of the categories were not within the verbal repertoire of two- and three-year-olds, the demonstration of equivalence of recovery within categories and distinctiveness between categories would further support the notion that meaningful categories develop perceptually and attentionally before they are developed verbally.

A more exploratory focus of this study is on sex differences in conceptual generalization of habituation. Although many studies of infant habituation have ignored sex differences, there are persistent indicators of sex differences both in habituation and recovery of visual attention in response to change. Friedman, Nagy & Carpenter (1970) found that male neonates showed greater habituation to 2 x 2 checkerboards than to 12 x 12 designs, while females habituated more to the latter. Cohen, et. al. (1971) found greater habituation, as well as

proportionately greater recovery, in males than in females at four months of age. Pancratz & Cohen (1970) found greater habituation in one group of males (also at four months) and a correspondingly greater response to novel test stimuli than was characteristic of females. Cornell & Strauss (1973) found four-month-old infant males had steeper habituation curves than females and more generalization of habituation to stimuli with familiar components than stimuli with novel components. Results for females were inconsistent and seem more explainable as stimulus preference. Although females did show habituation and dishabituation to both types of stimuli, they discriminated components independent of their degree of novelty. The latter three studies used simple, geometric shapes and all four studies employed a fixed presentation rate. It appears from the infant habituation literature as reviewed here, and by Jeffrey & Cohen (1971) that when there are sex differences, there is an interaction among sex, stimulus novelty, situational novelty, and possibly duration of exposure of the familiar stimulus.

The present study is designed in part to determine whether by age three years, males are simply more reactive than females to any change in stimulation, or whether the female steady-state performance may be indicative of more effective assimilation of new stimuli to attentionally based schemas. If the later is true, then males should show nearly equal dishabituation to all new stimuli, whether they represent the habituated category or a novel one, while females should show recovery of attention primarily to the categorically novel stimuli, but not to categorically similar stimuli.

This study was further designed to use a subject-control procedure (Horowitz, Paden, Bhana & Self, 1972). The primary advantage of this procedure is in adjusting the duration of stimulus exposure to the momentary inclinations of individual subjects, with the result that fewer subjects are lost or decline to continue, due to either too high or too low a rate of presentation. The subject-control procedure is considered to be more comparable to processes the child normally uses in learning from his natural environment than is a fixed, experimenter-controlled schedule.

Method

Subjects

The subjects in this study were 33 toddlers from a university preschool and three more toddlers from the surrounding area. The sample ranged in age from 29 months to 44 months with an average age of 40 months. They were randomly assigned to six groups of six, counterbalanced for sex. The six groups were differentiated in the design only by assignment of categories of stimuli to sets for purposes of counterbalancing. The treatment of all groups was the same except for this rotation of particular categories across sets.

Apparatus

The apparatus used has been described by Wright (1970) and is designed for video recording of gross eye movements in young children. The subject's chair, with cushioned headrest, is tilted backward about 30 degrees so the child's head is comfortably supported, but is otherwise unrestrained. This position also produces a favorable camera angle for

video-taping eye movements. The child faces a large (36 x 26 in.) back-projection screen located 24 inches from his face. The slides are changed by an extended lever which the subject can reach without moving his head. Either a right-hand or a left-hand lever can be used by the child. There are adjustable stirrups at either side of the front chair legs which raise and support the child's feet. A TV camera just under the screen and a video recorder were used to tape each session, and an observer scored on- or off-stimulus fixation of the subject's eyes from the TV monitor. The observer used a simple two-button switch, one depressed continuously when the subject was looking at the slide (on-stimulus) and one for when he was looking off the slide. The observer watched the monitor live, and her button presses were recorded on an Esterline-Angus event recorder for subsequent analysis of on-stimulus looking times. The event recorder also recorded the subject's slide changes and the phases of the experiment. The Experimenter controlled the phases of each session and used a forward-reverse lever to program presentation of the habituation series repeatedly at a rate controlled by the subject.

Later some of the video tapes were viewed by a second observer who independently scored on-off looks on the event recorder. The original and second event records were then compared to assess observer reliability, scored as percent of chart blocks (each .625 seconds long) on which the two records agreed that the subject was either looking on or off the stimulus. The average agreement assessed on six different subjects distributed over groups and sessions was 89%.

Stimuli

The stimuli were 2 x 2 color slides made by photographing pictures from books or real objects. The pre-post series contained 18 slides each, some of familiar objects such as preschool play equipment, and some of less familiar scenes, like patterns and textures from the natural environment. The three categories of slides used for habituation and generalization consisted of 12 food slides, 12 animal slides, and 12 environmental pattern slides. Each conceptual category of 12 slides contained a series of six used for the habituation set and a matched series of six (similar set) used in the test series to probe for generalization of habituation within the category. Following presentation of the pretest and the habituation set repeated to criterion, a test series of 18 slides was presented. In scrambled order, this test series consisted of the six habituated slides (familiar set), the remaining six slides in the habituated category (similar set) and six of the slides from another category (novel set). The posttest followed immediately, consisting of 18 miscellaneous slides very similar to the 18 pretest slides.

Procedure

With one exception because of illness, the children were run on three consecutive days. For one child six days elapsed between the first and second experimental sessions. After becoming acquainted with the children in their classroom, the experimenter took each subject by appointment to the experimental room, which contained the described apparatus, a one-way mirror to the adjoining observation room, and a small chair for the experimenter. The first session was spent familiarizing the subject with the procedure, using a set of practice slides of the nurse in the preschool, with whom all the children were acquainted, some pictures of

the preschool, and some other miscellaneous slides that were unrelated to any of the slides in the next two sessions. The experimenter sat so as to be out of sight of the subject. Due to the short attention span and general restlessness of such young subjects on such a long task (90 slides), the experimenter occasionally had to adjust the child in the chair or encourage him to go on. Talking was held to a minimum, and as much as possible adjustments and talking were done during the blank slides between sets. Moreover, when the child did talk to the experimenter, he typically looked away from the screen to do so. Therefore looking times (on-slide) were not grossly affected by such distractions.

When brought to the room, the child was given a choice of small dime-store toys and the toy he selected, which he received for finishing the session, was placed under his chair. The child was told that he could change the slides all by himself and when he got tired of a picture to go on to the next one. The experimenter made sure the child was pressing the slide-change lever correctly during the practice session. In the first and second experimental sessions, three warm-up slides were presented, and then the experimenter said, "Now I will sit right here. You can change the slides all by yourself and we can talk when you are through."

The experimenter held the forward-reverse switch controlling the direction of rotation of the slide projector drum in her hand while the child changed the slides. During the habituation phase this enabled the child to go through the habituation category of six slides repeatedly, forward, then backward, etc. at his own pace.

The criterion for habituation was defined as completion of 36 exposures (six times through the series of six slides) or a refusal to continue, whichever occurred first. During the 72 experimental sessions, 10 subjects declined, at one session each, to continue before completion of 36 exposures, but only two declined as early as the third repetition of the set. Following habituation criterion, all subjects agreed to continue with "some different pictures" and all completed their sessions.

In summary, after the practice session the two experimental sessions consisted of four phases: a pretest of 18 miscellaneous slides, a habituation phase in which the six slides of the habituation set were presented repeatedly to criterion, a test series containing familiar, similar, and novel sets in scrambled order, and a posttest of 18 miscellaneous slides.

Results

Differences between groups

Since the six groups differed only in assignment of categories to sets in the two sessions, a preliminary comparison of the six overall group means was made. Looking times (on-stimulus) in seconds per slide for each group were averaged over the last three habituation runs (h), the familiar (f), similar (s) and novel (n) test slides, and over both sessions, and for the sexes combined. The resulting means are shown in Table 1. A one-way analysis of variance was performed on these means and

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Insert Table 1 about here

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yielded a significant difference among the six groups (F (5,30) = 3.32; $p < .025$). Nevertheless, groups have been collapsed in the remaining analyses, except where categories are a factor.[1]

Main effects

Figure 1 shows the results of the last three runs of the

Insert Figure 1 about here

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habituation sets (h) and the test series (f, s, and n) by categories. The main effect of familiarity (relationship of h, f, s, and n) was apparent for each category used. The shortest on-slide looking times were at the end of the habituation (h) set. Dishabituation was obtained for the same slides, presented again in the test series, now termed familiar (f). Generalization of habituation was obtained on similar slides (s) during the test series, and the longest looking times were associated with the novel (n) test slides. An analysis of variance was run on each session separately.[2] For Session 1 a significant effect of familiarity was obtained (F (3,90) = 10.75; $p < .001$). There was no significant effect of categories (F (5,30) = 1.61) and no significant interaction between categories and familiarity (F (5,90) = .72). For Session 2, again only the effect of familiarity was significant (F (3,90) = 17.39; $p < .001$). The Bonferroni t-test (Wike, 1971) was used to test the correlated means for each Session. For Session 1 the differences between the means for h and n; f and n; and h and s were all significant (crit. diff. = 0.77). For Session 2 the differences between the means for h and n; f and n; s and n; and h and s were all significant (crit. diff. = 0.69).

Habituation within and between sessions

Table 2 shows evidence of response decrement during

Insert Table 2 about here

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the session from pre-miscellaneous set to post-miscellaneous set in both sessions, and an overall decrement from Session 1 to Session 2. Combining pre- and post-miscellaneous sets within sessions yielded an overall decrement from Session 1 to Session 2 of .12 seconds per slide, which was not significant. On Session 1 there was a mean pre-post decrement of .44 seconds per slide and on Session 2 there was a pre-post decrement of .54 second per slide. For both sessions combined, there was a pre-post decrement of .49 second per slide, and this was significant (F (1,35) = 7.75; $p < .05$). There was also a significant interaction between pre-post and Sessions (F (1,35) = 15.00; $p < .005$), showing a greater pre-post decrement in the second session.

Table 2 also shows response decrement from first habituation run to last habituation run. Three t-tests (Wike, 1971/p. 66) were used to compare first habituation run with last habituation run, and all decrements were significant: for the first session (t (35) = 4.04; $p < .001$); for the second session (t (35) = 4.30; $p < .001$); and for the sessions combined (t (35) = 3.90; $p < .001$).

Sex differences

Figure 2 shows the habituation and test effects by sex and session.

Insert Figure 2 about here

The same rising h, f, s, n gradient as described in Figure 1 again appears. One exception is that there was lower response to the similar slides than the familiar slides during the test set of Session 2 for females.

An analysis of variance was performed on the data in Figure 2, collapsing the data across sessions and categories. There was no significant overall difference between the sexes. A significant effect of familiarity was again obtained (F (3,102) = 18.12; $p < .001$). The Bonferroni t-test was used to test the correlated means, and the differences between the means h and s; h and n; and f and n were all significant (crit. diff. = 0.68). Bonferroni t-tests were done separately by sex for familiarity, and differential patterns were found for the sexes. Although the difference between f vs. s was not significant overall, nor for the females, it was significant for males (crit. diff. = 0.68). The difference between s and n was significant overall and for females, but was not significant for males analyzed separately. In other words females generalized within categories more than males and males discriminated between previously habituated and new slides, regardless of categorical similarity, more than females.

Discussion

The results of this study show some common phenomena of habituation. Response decrement during repeated presentation of a small set of stimuli parallels previous findings with single stimuli. Dishabituation or recovery of attention was demonstrated when habituated stimuli were intermixed with new ones, although the recovery was not statistically significant. The new stimuli themselves elicited still more attention than the familiar ones. There was significant general response decrement of short-term duration over the habituation trials, longer term decrement within sessions (pretest - posttest) and some decrement (not significant) between sessions (Session 1 - Session 2).

The fact that new (similar) slides from the habituated category were looked at more than the habituated (familiar) slides indicates that the obtained generalization could not exclusively be due to a failure to discriminate old from new stimuli within the habituated category. Conversely, the fact that novel category slides were looked at longer than new slides from the habituated category indicates that the categorically similar test slides were responded to as functionally equivalent (in part) to the familiar instances of the same category, whereas the categorically novel slides were not. These effects were obtained with all three categories used. Taken together these evidences for generalization within, but not between conceptual categories are consistent with Jeffrey's (1968) serial habituation hypothesis for the formation of simple schemas and with that of Collard and Rydberg (1972) that generalization of habituation should be an early indicator of concept formation in young children.

Two alternative explanations for the main results need to be considered. One is that the generalization gradients obtained result exclusively from primary stimulus generalization, rather than from conceptually mediated generalization. After all, it could be argued, slides for fruits have certain structural stimulus elements in common that are generally lacking in slides of animals, such as uniform color, roundness, homogeneous backgrounds, and the like. Environmental patterns, moreover, have the stimulus property of being generally "bled" to the edge of the slide, while both fruits and animals have a centered object on a distinctive background. Animals, correspondingly, tend to have more appendages on the central figure than do fruits, and ours were pastel drawings instead of photographs. New data based on slides having homogeneous textural

and figural properties, while differing in category membership, would be needed to rule out this possibility with certainty. However, it may properly be pointed out that certain animals (a crouching bunny) and environmental patterns (a man-hole cover) have the physical properties most commonly characteristic of the fruit category (a rounded, homogeneously colored figure centered in the slide). Correspondingly there were certain fruits (a bunch of cherries on connected stems) and certain environmental patterns (an automobile grill) which had the structural feature (appendages to a central mass) characterizing the animal category. In short, the authors are inclined to doubt that these results could be interpreted as reflecting only primary stimulus generalization, though doubtless some of that contributed to them.

A second alternative explanation might be based on the argument that what we have called perceptually mediated generalization might in fact be verbally mediated generalization, or at the very least a product of previous learning in the form of acquired distinctiveness of cues between categories and acquired equivalence within them. It is certain that many of the stimuli were recognized and named by the children, and they sometimes asked names they didn't know or named a picture incorrectly. On the other hand no children used categorical names, either conventional or idiosyncratic, to identify selectively any of the three categories used in the experiment. Thus verbalization as a means of enhancing within-category equivalence and/or between category distinctiveness does not appear to have played an overt role. It could still be argued that these categories are familiar to young children and that they may well have had prior learning opportunities that would enhance homogeneity within

and sharpen boundaries between categories. It was for this reason that the anomolous category, "environmental patterns", was included. Not only do the items in this category share very few perceptual features in common, but it is not likely children of this age could apply a single common label to them. Of course there remains the remote, but logical possibility that children identified the category of environmental patterns by exclusion; that is, "any picture that is neither fruit nor animal." The established difficulty of concept formation by negative instances, especially for young children, would however, mediate against such a possibility.

Although the main effect of sex of subject was not significant, it did interact with type of test slide. This interaction is provocative in the light of previous findings of sex differences with infants. The generalization gradient in order of increasing recovery goes from habituated, to familiar, to similar, to novel slides. For each sex there were thus six possible contrasts testable by the Bonferroni t-test. All 12 of these contrasts were consistent with the hypothesis that females recovered primarily to categorical novelty and males recovered primarily to absolute novelty. Habituated vs. familiar slide looking did not differ significantly for either sex. Novel slides were looked at longer than either habituated or familiar slides for both sexes. Similar and novel differed significantly for girls, while similar and familiar did not. For boys, the opposite was the case: similar and familiar differed significantly, while similar and novel did not. It is, of course, debatable whether this result is to be regarded as indicating better conceptual development of categorical equivalence in females, or better recognition memory and discrimination of novelty in the male, or both.

There is more than one explanation for these results. One might hypothesize that after having some experience with the task, females adopt a self-instruction to categorize, while males adopt a self-instruction to detect new slides. One obvious strategy for future research would thus be to provide each set of instructions explicitly to separate groups of males and females.

Another hypothesis is that females are showing greater conceptual maturity as Kagan (1969) suggests. If this is so, a research design incorporating additional sessions with new categories might allow the males enough time and experience to develop a conceptual set. Alternatively, replication with males and females of various ages might distinguish a single developmental sequence on which females are more advanced.

An important methodological feature of this study was the subject-control procedure. Given that subjects controlled their own slide changes, it would have been simple and convenient to record self-presented slide-on time as an index of attention. Instead, time spent looking at each slide was used as the dependent variable. A post-hoc analysis shows that if only duration of slide presentation had been used, the results would have been very different. The distinction between attention to familiar, similar, and novel slides would have been obscured, and durations would have all been much longer. Using a subject-controlled presentation rate therefore does not permit the experimenter to bypass visual fixation as the primary measure of visual attention.

Conclusions

Habituation of visual attention occurs in young three-year-olds with repeated presentation of a group of categorically similar stimuli. Recovery of looking at these slides is demonstrated when they are intermixed with others. Progressively greater recovery of looking occurs to new (but similar) slides from the habituated category and still greater to new slides from a novel category. Males showed a gradient with the sharpest increase in looking occurring between previously habituated stimuli and new slides from the same category. Females, however, showed a gradient with the sharpest increase occurring between new slides of the habituated category and new slides from a novel category.

While habituation is present in three-year-olds, it may have begun to give way to other processes of learning that predominate in older children. It is likely that habituational/perceptual mediators are replaced by verbal and conceptual processes. Habituation may or may not continue to indicate perceptual learning in the older child. Nevertheless these data show an orderly process indicative of selective generalization of a response (habituated looking) within categories of stimuli, but not between categories, regardless of how the child may have achieved the grouping. Such data indicate the existence of at least short-term categorical grouping in toddlers.

Generalization, or in this case categorical equivalence, could result either from a failure to discriminate new from old members of the habituated category or from formation of a schema of equivalence that matches the category definition used by the experimenter. Correspondingly

strong dishabituation or recovery of attention to categorical novelty could result from either a high detection acuity for any stimulus change or from discrimination of a change in stimulus categories. Only when good generalization is demonstrated within categories and good discrimination between categories can a case be made for the presence of concepts. This outcome was most clearly obtained during the second session by females.

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Footnotes

Unnumbered

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1. Another analysis was done leaving out Group 4, which contributed the largest mean due to two subjects who had unusually high means. The analysis yielded no significant difference between the remaining five groups (F (4,25) = 1.70; n.s.).

2. Sessions were analyzed separately so as to avoid a partially repeated measures design in which interactions would not be testable.

Table 1

Overall Means and Standard Deviations of On-slide Looking Times (in seconds) for Each Group

Group	Mean	Standard Deviation	Session 1		Session 2	
			Habituated	Novel	Habituated	Novel
1	2.91	1.26	Food	Animals	Animals	Patterns
2	3.14	.86	Animals	Patterns	Patterns	Food
3	2.00	.26	Patterns	Food	Food	Animals
4	4.14	1.45	Food	Patterns	Patterns	Animals
5	2.86	.78	Animals	Food	Food	Patterns
6	2.56	.57	Patterns	Animals	Animals	Food

Table 2

Habituation of On-slide Looking Times (in seconds) by Sessions: Pre-post Miscellaneous and First-last Habituation Runs

	Session 1 Means	Session 2 Means	Combined Session Means
Pretest	3.75	3.68	3.72
Posttest	3.31	3.14	3.23
1st Run of Habituation	3.07	3.12	3.09
Last Run of Habituation	1.91	1.97	1.94

Figure Captions

Figure 1. Looking Times at Habituated, Familiar, Similar, and Novel Slides by Category.

Figure 2. Habituation by Sex, Sessions, and Familiarity.

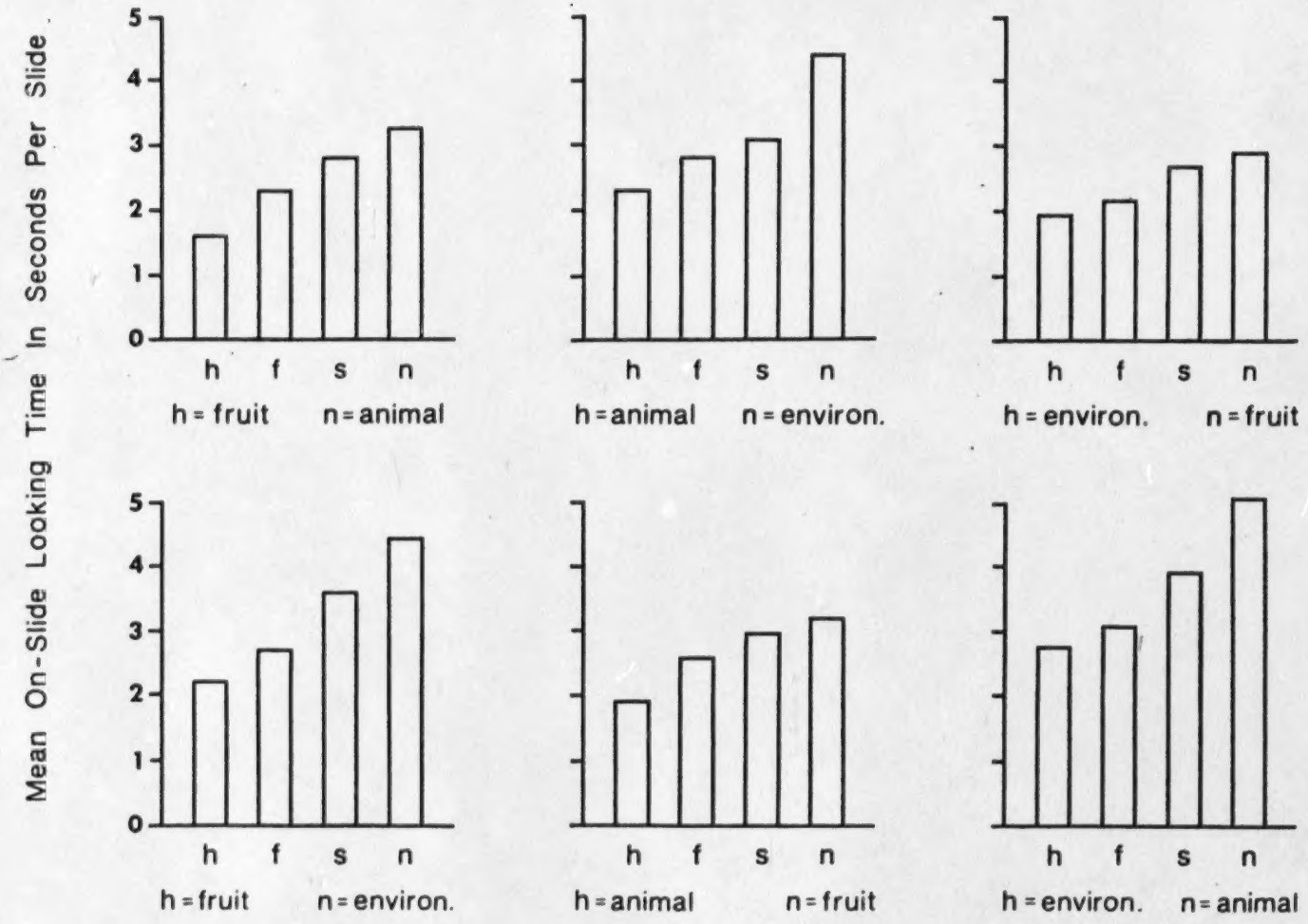
Mean On-Slide Looking Time In Seconds Per Slide
0
1
2
3
4
5
h f s n
h = fruit n = animal
h = animal n = environ.
h = environ. n = fruit
h = fruit n = environ.
h = animal n = fruit
h = environ. n = animal

Fig. 1

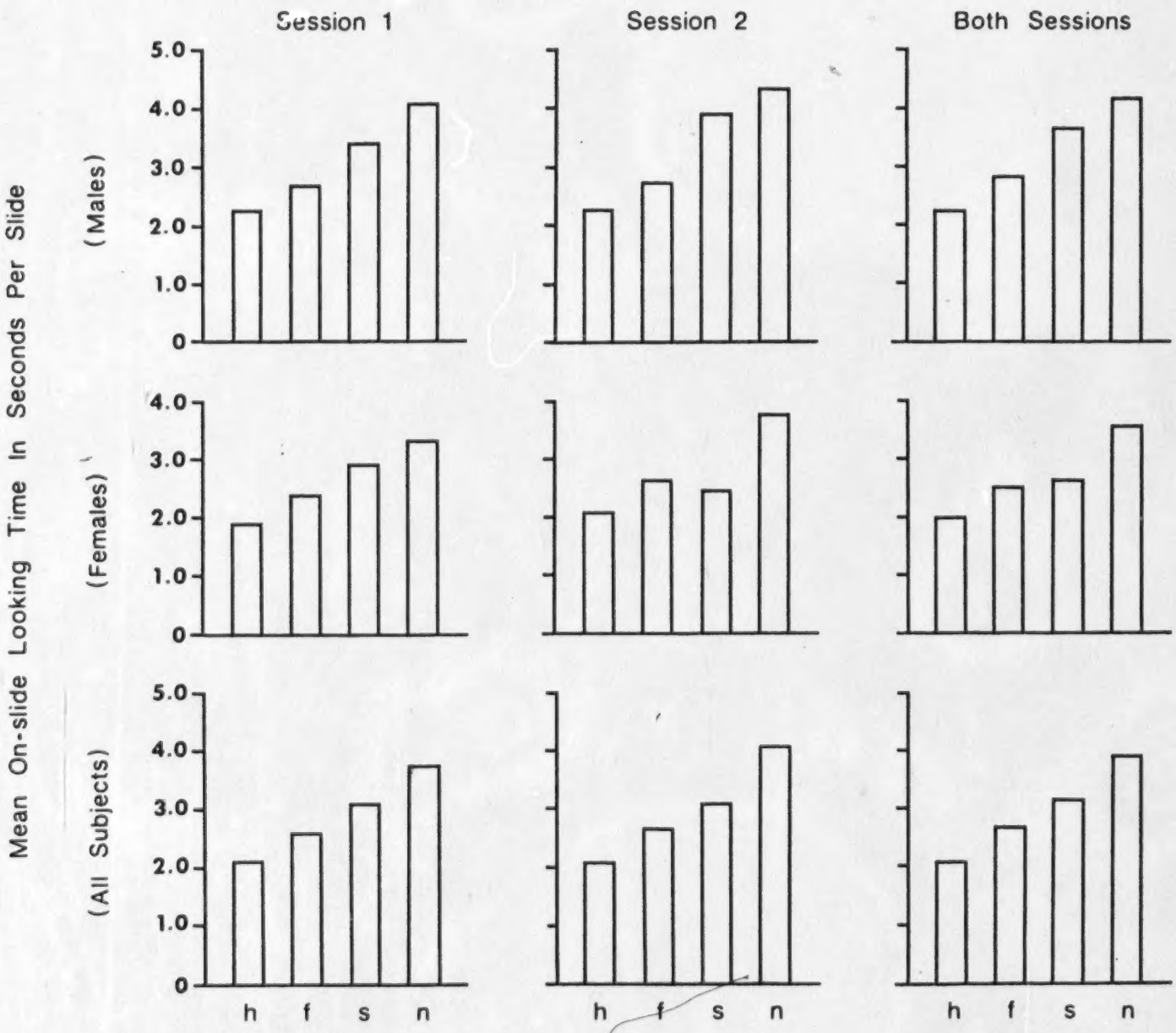
Session 1
Session 2
Both Sessions
Mean On-slide Looking Time In Seconds Per Slide
(Males)
(Females)
(All Subjects)
5.0
4.0
3.0
2.0
1.0
0
h
f
s
n

Fig. 2